AIR EXCHANGE ATTENUATION APPARATUS

FIELD OF THE INVENTION

The present invention relates to an apparatus for attenuating the exchange of air in containers that are not airtight, in particular freight containers, and to a freight container provided with such apparatus.

BACKGROUND OF THE INVENTION

Cargo of various kinds is shipped in aluminium or steel freight containers usually being approximately 8x8x20 or 8x8x40 feet in size. Recently a freight container approximately 8x8x13 feet in size has been proposed as a new standard (WO 01/62631). A modular freight container of this sort is of generally rectangular parallelepipedal form and comprises a base, a pair of opposed side walls, at least one of which comprises a door, usually a double wing door, for loading and unloading freight, and a roof. The walls are usually made of corrugated plate. While freight containers are made to withstand severe weather conditions they are generally not airtight. To seal them completely is costly.

Due to changes in temperature of the air inside of the freight container or in the atmosphere surrounding it, changes in atmospheric pressure, wind pressure, and the like, a difference in pressure between the air in the container and that surrounding it may be created, causing humid air to leak into the container from outside and affect cargo that is sensitive to humidity. As a precautionary measure drying devices, such as the one disclosed in WO 01/25707, are disposed in freight containers carrying sensitive cargo. The drying capacity of such devices is however limited. The problem of keeping the air in the container dry is enhanced by

cargo of high specific weight. Due to its limited loading capacity only a minor portion of the freight container may be loaded with such cargo, for instance, humidity sensitive metal powders. For a given difference in air pressure the volume of humid air that enters the freight container increases in proportion with the empty space in the container. This aggravates the humidity problem.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a means for attenuating the exchange of air between the air in a container of the aforementioned kind and the surrounding atmosphere.

Further objects of the invention will become evident by the following summary of the invention, the description of preferred embodiments illustrated in a drawing, and the appended claims.

SUMMARY OF THE INVENTION

According to the present invention is provided an apparatus for attenuating the exchange of air in a freight container with the surrounding atmosphere, comprising a flexible but substantially not resilient membrane which delimits within the container a first air volume from a second air volume in which cargo sensitive to humidity is stored, the first air volume being in communication with the surrounding atmosphere and capable of varying as a result of differences between atmospheric pressure and the pressure in the second air volume. It is preferred for the membrane to comprise a sealing means extending along its circumference. Preferably the membrane has the form of a thin-walled plastic bag or trough along the circumferential edge of which the sealing

means is provided in form of an adhesive. The sealing means may, however, also be provided separately, for instance, in form of a clamping or lacing means or similar. By the sealing means the membrane is put in communication, directly or indirectly, with an opening in the container wall. Thereby communication between the first volume delimited by the membrane and the atmosphere surrounding the container is established. It is important that the membrane does not easily collapse by its own weight. Therefore it should be as light as possible. Particularly preferred are membranes of polymer material, such as polyethylene, polypropylene, and the like. Particularly preferred is pre-stretched polyethylene or polypropylene foil. Typically the membrane will have a thickness of 0.05 to 0.3 mm. In other words, the movement of the membrane should, as far as possible, only be caused by a difference in air pressure between the first and the second volume. It is preferred the first volume to be set at about half its maximum when mounting the membrane.

According to a first preferred aspect of the invention, in which the membrane is put into direct communication with an opening in the container wall, the sealing means comprises a rectangular frame capable of being mounted so as to make the membrane cover a door opening of the container; in such case a means for attaching the frame to the rebate of the door, such as an adhesive, is provided on the frame or on the rebate or both. Thereby the frame can be glued to the rebate of the container door after the container has been loaded with cargo, whereafter the door is closed. The first air volume in the container thus is formed between the membrane and the closed door; its communication with the atmosphere surrounding the container is by leaks between the door and the rebate and between the door wings if a door with wings is used. A membrane mounted in this manner utilises the leaks which normally occur at a container door and which most

often are more prominent than the sum of other leaks in the container. A further advantage is provided in that the freight container door can be opened for visual inspection of the cargo without admitting humid air to the second volume in which the cargo is stored. Such inspection is common in case of interstate transport during which the cargo may be inspected by custom officers before being shipped to the final destination and unloaded. For this reason it is preferred for the membrane or a portion thereof to be made in a transparent material. It is also possible to put the volume defined by the membrane in direct communication with an opening in a wall of the freight container that is not a door opening and which will have to be provided separately, thereby defining said first volume. This is achieved by, for instance, gluing the free circumferential edge of a plastic bag to an inside portion of the container wall surrounding the opening. The free circumferential edge of the bag may also be mounted on a short tubular connection piece provided with a circular flange at its one end, the flange being fixed to the inside portion of the container wall surrounding the opening. In spite of the interposed connection piece the membrane still can be considered to be put in essentially direct communication with a through opening in a container wall.

According to a second preferred aspect of the invention, the sealing means is put in indirect communication with a through opening in a freight container wall. The through opening is not a door opening and has to be provided separately, for instance, by drilling a hole in the container wall. In particular, the sealing means comprises an assembly for mounting the membrane to a container wall having a first through opening which is not a door opening in a manner to provide substantially unrestricted communication between the first volume and the surrounding atmosphere through the first through opening. The mounting assembly comprises an element

for interposition between the first through opening and the assembly, the interposition element comprising a means for its fixation to the container wall in a manner so as to make it cover the first through opening, the fixation means comprising a first through bore for its fixation to the remainder of the mounting assembly and a second through bore for providing communication of atmospheric air to the first air volume.

According to a variation of the second preferred aspect of the invention the mounting assembly comprises a means for its fixation to a second through bore in the container wall disposed adjacent to the first through bore. Also this second through bore has to be provided separately. It is preferred for the mounting assembly to comprise a mounting stud, a first tube extending from the mounting stud generally perpendicular to the stud axis, a second tube slidingly and sealingly disposed on the first tube or in the first tube, the second tube having, in respect of the stud, a an open proximal end and a closed distal end and comprising a neck extending from its closed end for air-tight fixation of membrane. It is also preferred for the mounting assembly to comprise a means for suspending the first or the second tube on a lashing eye fixed at the container wall. Such eyes are standard in most freight containers. The design of the mounting assembly allows it to adapt to variations in distance between the bore or bores in the container wall at which or near which the assembly is mounted, and the eye at which the second tube with the membrane is suspended about horizontally, albeit deviations from the horizontal level may be tolerated.

Except for direct or indirect (by the interposed mounting element) mounting of the mounting assembly on the freight container wall the design of the mounting assembly of the second preferred aspect of the invention and the variation thereof is the same. The second tube is advantageously a corrugated tube which is slidingly and sealingly disposed on

said first tube. In such case it is preferred for the suspension means to be capable of being fixed onto the second tube by clamping. While the membrane may have any form that is suitable for delimiting the first volume from the second volume, it will most often take the general form of a bag with a rectangular or circular bottom.

According to a third preferred aspect of the invention the first volume is up to ten per cent of the second volume, even more preferred up to six per cent of the second volume, most preferred from up to four and up to ten percent of the second volume.

According to a fourth preferred aspect of the invention the first volume is comprised by two or more apparatus according to the invention. Thus, for instance, a first volume of up to six per cent of the second volume may be provided by two apparatus each having a first volume of up to three per cent.

According to a fifth preferred aspect of the invention the flow resistance of the communication between the atmosphere and the first volume is ten per cent or less of the flow resistance of the combined leaks to the second volume. Thus, if the pressure of the air surrounding the container rises, a volume of air will enter the first volume, which is correspondingly larger than the volume of air entering the second volume. In an opposite situation, in which the pressure in the container exceeds the surrounding pressure, a correspondingly larger volume of air will leave the first volume. Drying devices disposed in the second volume where the cargo is stored thus will have to cope with considerably smaller amounts of humidity and hence will last longer and keep the average humidity in the second volume at a lower level.

According to a sixth preferred aspect of the invention the mounting assembly comprises a mounting stud and a tube element extending from the mounting stud

perpendicularly or obliquely to the stud axis and being in fluid communication with the stud, the tube element comprising, at its free end, means for sealing fixation of the membrane; wherein it is preferred for the membrane to have the form of a bag and for the fixation means to comprise screw and/or hook means.

Also disclosed is a freight container provided with the apparatus of the invention.

The invention will not be explained in detail by reference to a number of preferred embodiments illustrated in a drawing.

SHORT DESCRIPTION OF THE DRAWING

Fig. 1 is a perspective view of a freight container, with portions of its end and side walls and its roof removed, provided with two pressure equalisers according to the invention, each consisting of a mounting assembly and a collapsible bag, mounted on the left container wall;

Fig. 2 is an enlarged partial view of one of the pressure equalisers in Fig. 1, in the same view;

Fig. 3 is a still more enlarged partial view of the mounting assembly of the pressure equaliser of Fig. 2, with the container wall omitted, in the same view;

Fig. 4 is an axial section (C-C; Fig. 7) corresponding to Fig. 3 but with a portion of the collapsible bag also shown;

Fig. 4a is an enlarged partial view of Fig. 4, illustrating the connection between the mounting assembly and the collapsible bag;

Fig. 5 is a section (B-B; Fig. 3) through the suspension device of the mounting assembly;

Fig. 6 is a top view (in the same direction as the view in

Fig. 3) of the arrangement of through bores in a lock disk covering a larger through bore in the container wall;

Fig. 7 is an axial section (A-A; Fig. 4) of the proximal end portion of the mounting assembly of Fig.3, in a mounted state;

Fig. 8 is a partial view of a the proximal end portion of the mounting assembly of a second embodiment of the pressure equaliser of the invention, in a mounted state and in a view corresponding to that in Fig. 7;

Fig. 8a is a section through a lock for sealing through bores in the container wall that had been provided to allow the mounting of the embodiment of Fig. 8;

Fig. 9 is a perspective view of a third embodiment of the pressure equaliser of the invention;

Fig. 10 is a partial perspective view of a freight container, with the door wings removed;

Fig. 11 is a perspective view of the embodiment of Fig. 10 mounted in the rebate of the doorframe of the container of Fig. 10;

Fig. 12 is a perpendicular section through the frame of the embodiment of Fig. 9;

Fig. 13 is an axial section of a fourth embodiment of the pressure equaliser of the invention, in a mounted state;

Fig. 14 is an axial section of a variation of the fourth embodiment of the pressure equaliser of the invention, in a mounted state.

DESCRIPTION OF PREFERRED EMBODIMENTS

The large freight container of Fig. 1 is 8x8x20 feet in size. It is of rectangular parallelepipedal form and comprises a base 2, an first end wall 5 provided with a double

wing door (not shown), right 1 (seen from the first end) and left 3 side walls (corrugation not shown on left section 3'), a second end wall 4, and a roof 6. The container walls are made of corrugated steel plate. The freight container is loaded with boxes 11, 12 on pallets. On the inner face of its left side wall 3 first 7, 9 and second 8, 10 pressure equalisers according to the invention are mounted, each comprising a mounting assembly 9, 10 and a collapsible bag 7, 8. The left pressure equaliser 7, 9 will now be described in more detail by reference to Figs. 2-7.

Firstly reference is made in particular to Figs. 3, 4 (section C-C in Fig. 7), and 4a. The mounting assembly 9 comprises a stud 14 the axis D-D (Fig. 7) of which is disposed perpendicular to the container wall 3. From the mounted stud 14 extends horizontally a tube 19 disposed about in parallel with the container wall 3. Its free end 26 facing away from stud 14 is open. Co-axially (axis A-A) and slidingly disposed on the tube 19 is a corrugated hose 15 against which it is sealed by a rubber ring 24 held in the first corrugation at its open end proximal stud 14. At its other, distal end the hose 15 is closed by a wall 25. Over a portion of the hose 15 extending from its closed end 25 in the direction of its open end the hose 15 is joined to a neck 16 of hollow truncated prismatic form which carries a bag mounting flange 20 at its base. Where the hose 15 and the neck 16 are joined a portion of the wall of the hose 15 is removed which provides for communication of the interior of the neck/flange portion 16, 20 with the lumen of hose 15 and from there with that of the tube 19. At its open end the collapsible bag 7 is mounted on the flange 20 and held there by a resilient U-profile ring 21.

The stud 14 and a portion of the tube 19 extending from it shown in section A-A (Fig. 4) in Fig. 7. The bore of stud 14 communicates with the lumen of the tube 19 by opening 32. The stud 14 is mounted on a flat portion 34 of the left

container wall 3 via a mounting disk 35 fixed by snap means 37 to a through bore in the flat container wall portion 34. The mounting disk 35 is provided with an array of through bores, a central bore 36 and eight peripheral bores 38 disposed in a rectangular pattern around the central bore 36 (Fig. 6). The central bore 36 is penetrated by the treaded end portion 29 of a locking screw 27, the head 28 of which is sealingly abutting a conical face 31 of the stud 14. The open end of the stud 14 seals against the mounting disk 35 by means of a polyurethane foam ring 33 mounted in a circular grove disposed at the free end face of stud 14. At its head face the locking screw 27 carries a grip 30 for turning it by hand. In Fig. 6 broken circles 39, 40, 41 indicate the inner and outer contours of sealing ring 33 and the contour of the bore in the container wall portion 34.

Fig. 2 illustrates the suspension of the mounting assembly 9 of the invention and the collapsible bag 7. A substantially flat suspension plate 18 is clamped onto the corrugated hose 15 by a finger 52 thereof so as to circularly enclose the corrugated hose perpendicularly to its axis A-A for an angle of more than 180^0. Opposite to the finger 52 the clamping plate 18 is provided with a hook 50 by which it is hung up on a lashing eye 13 of a kind normally provided on the inside wall faces of large freight containers. A support portion 51 disposed beneath the hook 50 abuts the container wall 3 in a mounted position and provides for correct distance of the mounting assembly 9 from the container wall 3. The sliding relationship of tube 19 and corrugated hose 15 allows the mounting assembly 9 to adapt to varying distances between lashing eyes, such as eye 13, and through bores in the container wall which determine the mounting position of the stud 14.

Figs. 8 and 8a relate to a second embodiment of the mounting assembly of the invention which differs from the

first embodiment by the omission of a mounting disk and the provision of the trough bore pattern of Fig. 6 directly in flat container wall portion 42, the central bore being identified in the drawing by reference number 46 and peripheral bores by number 48. In this embodiment the stud 44, which corresponds to the stud 14 of the first embodiment, abuts directly the flat wall portion 42 via its sealing ring 45. The stud 44 is fixed at the container wall by a deformable screw 43 secured in the central bore 46.

To protect the contents of the container when a pressure equaliser according the aforementioned embodiments of the invention is not mounted the bore(s) in the container wall can be covered by a lock disk in Fig. 8a. A lock disk 47 designed to cover the array of bores 46,48 provided in the freight container wall for mounting the second embodiment is shown fixed in bores 48 by snap fingers 49. A corresponding lock disk for use with the first embodiment would have the form of the mounting disk 35 but lack the bores 36, 38 thereof. A person skilled in the art will realise that the bores can be arranged in many other useful patterns.

A third embodiment of the invention is shown in Figs. 9-12. For mounting this embodiment makes use of the door opening of a freight container 60 where leaks are most prone to occur. The pressure equaliser of the third embodiment consists of thin polymer foil 62 in the rough form of a trough, which extends from the inner contour of a rectangular frame 63. The frame 63 is of a size to make the polymer foil trough 62 fit exactly into the freight container door frame, that is, the inner contour of the frame 63 is substantially superposable to the inner contour of the door opening, and to allow it to be fastened to the rebate 61 of the door. A detailed sectional view of the frame 63 perpendicular to its inner and outer contours is shown in Fig. 12. At its peripheral edge the polymer foil trough 62 is clamped between

a U-formed sheet of cardboard to which it has been fixed by warming to a melting temperature of the polymer. A flange 66 of the cardboard sheet extends to protect the foil trough 62 against abrasive wear by the doorframe. The face of the cardboard frame 63 facing the rebate 61 is provided with an adhesive 64 which is protected by a ribbon 65 of non-sticking material. Prior to mounting the ribbon 65 is removed.

A fourth embodiment of the invention is shown in Fig. 13. The mounting assembly comprises a stud 114 the axis of which is disposed perpendicular to the container wall 134. From the mounted stud 114 extends downwards and away from the container wall 134 a funnel-shaped piece 119 ending in a neck 120. The neck 120 serves for mounting a collapsible plastic bag 107 the wall thickness of which is greatly exaggerated in the Figure. The bag 107 is secured on the neck 120 by a hose clamp 140. The bore of the stud 114 is in communication with the lumen of the funnel-shaped piece 119. The stud 114 is mounted on a flat portion of the container wall 134 via a mounting disk 135 fixed by snap means 137 to a through bore in the wall 134. The mounting disk 135 is provided with an array of through bores, a central bore and eight peripheral bores 138 disposed in a rectangular pattern around the central bore similar to the bore array in Fig. 6. The central bore of the array is penetrated by the treaded end portion 139 of a locking screw 127, the head 128 of which is sealingly abutting a conical face 131 of the stud 114. The open end of the stud 114 seals against the mounting disk 135 by means of a polyurethane foam ring 133 mounted in a circular grove disposed at the free end face of stud 114. At its head face the locking screw 127 carries a grip 130 for turning it by hand. In a variation of the mounting assembly of Fig. 13 the mounting disk 135 can be dispensed with and the screw 127 mounted in the central bore of a bore array corresponding to that in Fig. 6 or in any other suitable array. In this

variation the bore array is arranged directly in the container wall similar to that shown in Fig. 8.

A variation of the fourth embodiment is shown in Fig. 14. The mounting assembly comprises a stud 214 the axis of which is disposed perpendicular to the container wall 234. From the mounted stud 214 extends downwards and away from the container wall 234 a funnel-shaped piece 219 ending in a neck 220. The neck 220 serves for mounting a collapsible plastic bag 207 the wall thickness of which is greatly exaggerated in Figure 14. The bag 207 is secured on the neck 220 by a hose clamp 240. The bore of the stud 214 is in communication with the lumen of the funnel-shaped piece 219. The stud 214 is mounted on a flat portion of the container wall 234 via a mounting disk 235 fixed by snap means 237 to a through bore in the wall 234. The mounting disk 235 is provided with an array of through bores, a central bore and eight peripheral bores 238 disposed in a rectangular pattern around the central bore 239 similar to the bore array in Fig. 6. The central bore 239 of the array is penetrated by the end portion 228 of an L-shaped locking hook from the shaft 227 of which it extends perpendicularly. A threaded portion 229 extending from the free end of the shaft 227 passes through an end wall 231 of the stud 214. In a mounted state the end wall 231 is disposed about parallel with the container wall 234; a wing nut 232 threaded on the threaded portion 229 of the shaft 227 is tightened against the end wall 231 to press the stud 214 against the mounting disk 235. The open end of the stud 214 seals against the mounting disk 235 by means of a polyurethane foam ring 233 mounted in a circular grove disposed at the free end face of stud 214. Alternatively the mounting disk 235 can be dispensed with and the hook 227, 228 mounted in the central bore or any other bore of a bore array corresponding to that in Fig. 6 or in any other suitable bore array. In this case

the bore array is arranged in the container wall in a manner similar to that shown in Fig. 8.